Analog & Digital Electronics

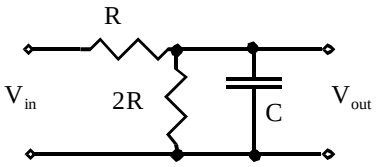
For all the homework assignments, give any numerical answers to at least two significant figures. Also leave a margin of about 1 inch on the left side of the paper for me to write in.

Assignment 3: Turn in the problems below on **Monday, Feb. 26**.

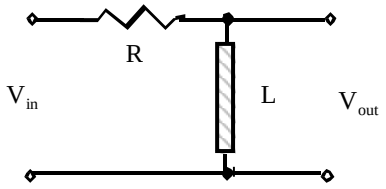
1. What is the impedance of a resistor R and a capacitor C in parallel? What is the magnitude of the impedance as
   a) $\omega \rightarrow 0$
   b) $\omega \rightarrow \infty$

2. What is the impedance of a resistor R and an inductor L in parallel? What is the magnitude of the impedance as
   a) $\omega \rightarrow 0$
   b) $\omega \rightarrow \infty$

3. Given the circuit at the right, calculate the complex transfer function (as a function of angular frequency ω). Also find its magnitude and phase as a function of angular frequency. You may find it useful to apply Thevenin's theorem to the source and the two resistors.



4. Given the circuit at the right, calculate the complex transfer function (as a function of angular frequency ω). Also find its magnitude and phase. Note that the box is an inductor. (I can't draw them very well on the computer.) Describe how this circuit will "treat" high and low frequency inputs. At what frequency are the magnitudes of the impedances of the inductor and the resistor the same?



5. I have a low pass filter with a 10nF capacitor and 16kΩ resistor. If the input is
   $V(t) = 2V\cos(2000\pi t/s)$
   a) Find the current through the capacitor as a function of time. (The Real Current)
   b) Find the current through the resistor as a function of time.

6. I have a high pass filter that uses a 33k resistor and a 1.0nF capacitor. (You only need to be accurate to 3% or so for the three questions below.)
   a.) What is the cutoff frequency in Hz?
   b.) If the input signal is 20 kHz, how much will it be attenuated?
   c.) If the input signal is 1kHz, How much will it be attenuated?

If you want practice with complex numbers, find the polar form for the following expressions. Assume ω, τ and t are real numbers. (I'm not going to grade them.)

1. 3j
2. $\frac{4}{3j}$
3. (7j -6) + (4j – 9)
4. $\frac{(3+2j)}{(1-j)}$
5. (2 + 3j)×(6j)
6. $(2-j)^2$
7. $(3+2j)^3$
8. $2je^{j\omega t}$
9. $\frac{3+2j}{3e^{j\omega t}}$
10. $\frac{\omega\tau e^{j\omega t}}{1+\omega\tau}$

Useful Relations
(The frequencies have been rounded)

Resistor	Capacitor	τ	Frequency (Hz)
1.0 kΩ	1 nF	1.0 μs	160 kHz
1.6 kΩ	1 nF	1.6μs	100 kHz
10 kΩ	1 nF	10 μs	16 kHz
16 kΩ	1 nF	16μs	10 kHz
10kΩ	10 nF	100 μs	1.6 kHz
16 kΩ	10 nF	160μs	1.0 kHz